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Appearance of iron-dependent chemosynthetic ecosystem at the Southern Mariana Trough

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Microbial community structures in deep-sea hydrothermal vent fields may be constrained by available energy yields provided by inorganic redox reactions. Variability of fluid geochemistry of deep-sea hydrothermal vents in three geographically different areas of the Southern Mariana Trough (SMT) have been reported, and an unparalleled microbiological dataset of various samples (i.e., sulfide structures of active vents, iron-rich mats, borehole fluids and ambient seawater) collected in these areas are available for comparative analyses. Here, we summarize the microbiological and geochemical characteristics in the SMT and assess the relationship between the microbial community structures and the fluid geochemistry in the SMT by thermodynamic modeling. In particular, aerobic sulfide-oxidation has the potential to yield large amounts of bioavailable energy in the vent fluids, which is consistent with the detection of species related to sulfide-oxidizing bacteria (such as Thiomicrospira in the Gammaproteobacteria and Sulfurimonas in the Epsilonproteobacteria). Notably, the bioavailable energy yield from aerobic iron-oxidation reactions in the fluids collected from man-made boreholes and several natural vents were comparable to or higher than those from sulfide-oxidation. This is also consistent with the detection of species related to iron-oxidizing bacteria (Mariprofundus in the Zetaproteobacteria) in such samples. The combination of microbiological, geochemical and thermodynamic analyses in the SMT will provide novel insights into the presence and significance of iron-based microbial ecosystems in deep-sea hydrothermal fields.

Keywords: Chemosynthetic ecosystem, Deep-sea hydrothermal vent field, Iron-oxidizing chemolithoautotrophic bacteria, Thermodynamic modeling, Crustal fluid